"De-coupling clutch, particularly for marine use"

Field of the Invention

This invention relates to a de-coupling clutch, particularly for marine use.

Background of the Invention

In most existing marine drives in watercraft, a marine engine is coupled to a propeller via a gear box which provides a single gear ratio. The speed of the watercraft is controlled by controlling the engine speed via a throttle. Generally speaking, watercraft are geared so that they run most efficiently at their intended cruising speed. A large yacht may be designed to cruise at 35 to 40 knots and is thus geared to be most efficient and controllable at or around that speed. However a problem with this arrangement is that such craft are very difficult to operate at the low speeds that may be required, for example, when docking the craft. It is very difficult to dock a boat safely if, for example, the lowest speed that the boat will satisfactorily travel at, is around 10 knots. It is also, in some cases, desirable to have a low gear ratio for applications where increased torque is required, or where low speed operation (trolling) is required, with a higher gear ratio for high speed operation. Although a number of multi-speed drive transmissions have been proposed for watercraft, to address this problem, those transmissions suffer from a number of problems, principally relating to the cost, size and complexity of the transmissions. For example, US 6,350,165 discloses a watercraft which incorporates a two forward speed plus one reverse speed transmission which is based on a planetary gear apparatus and is consequently relatively high cost.

A further problem which occurs with watercraft, is "clunking" which occurs as a watercraft is put into forward or reverse gear. Whilst it is not a serious problem from an operational point of view, clearly a person spending a large sum of money to buy a watercraft, particularly at the more expensive end of the market, might expect to get a transmission system which does not "clunk" when the craft is put into gear.

It is an object of the present invention to address or alleviate at least some of the problems of the prior art.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a context for the present invention. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed before the priority date of each claim of this application.

Summary of the Invention

In a first broad aspect, the present invention concerns the provision of a decoupling clutch in a drive shaft, most preferably a drive shaft of a watercraft of the like. The decoupling clutch is separate from the transmission and is not associated with a gearbox or the like. The clutch does not change the direction of rotation of the drive shaft and has a single clutch area.

The advantage of having a single clutch area is that the clutch may be slipped at any speed or torque. This also allows for high energy launches and driveline protection.

A control system is provided for controlling slippage of the clutch. The slip speed of the clutch is controlled by monitoring both the input shaft speed and the output propeller speeds. The output speed may be used as an input to control the slip speed, allowing for clutch slip at any speed and torque.

This in one preferred aspect, the present invention provides a decoupling clutch system for use in a marine craft, the system including a decoupling clutch having a single clutch area and being separate from and not associated with a gearbox or the like, the decoupling clutch system including an input shaft for operative connection to a drive shaft of the marine craft, and being arranged to drive, via the decoupling clutch, an output shaft which, in use, is operatively connected to a propeller, jet drive or the like of the marine craft, the decoupling clutch system further including a piston or the like for controlling engagement of the clutch, a control system, means for monitoring the input shaft speed and transmitting the input shaft speed to the control system, means for monitoring the output shaft speed and transmitting the output shaft speed to the control system, the control system being arranged to control slippage of the clutch by monitoring both the input shaft speed and the output shaft speeds and adjusting the engaging forces on the clutch to adjust clutch slippage accordingly.

The decoupling clutch typically includes an input shaft and friction plates which are splined to the input shaft. Drive is provided to the output shaft through clutch plates which are splined to a clutch drum which is in turn, splined to an output shaft. Alternatively the output shaft and input shaft may be reversed, with the friction plates splined to the output shaft. A piston or the like may be provided to force the friction plates and clutch plates together to transfer drive from the input shaft to the output shaft.

In a preferred embodiment the force provided by the piston is controlled by controlling the pressure in the piston using direct acting high flow electro hydraulic

solenoids. A biasing means such as a return spring may be provided to disengage the piston.

The control system typically monitors driver input, input speed and output speed to control the output speed through control of piston pressure. The various modes may be programmed into the control means which using feedback from sensors automatically controls the piston to ensure that the system operates in the correct mode - normal, trolling, docking etc

The present invention provides a number of significant advantages over existing systems. By controlled slipping of the clutch or disengaging the clutch during forward or reverse gear engagement transmission "clunk" can be eliminated. By using controlled slip across the clutch automatically corrects for clutch wear/clearance, oil type, oil degradation, oil levels and is not affected by temperature.

The control of slip speed together with a single area clutch allows the clutch to slip at any speed or torque which achieves high energy launches and also protects the driveline of a marine craft when the craft's propeller contacts obstacles such as the sea bed, branches, rocks or the like.

Similarly controlled slippage of the clutch may also be used for slow speed operation of marine craft for trolling and docking functions without the need for a more complex and expensive two speed gearbox.

Further the present invention also allows additional functionality in the form of a "Hi-launch energy" mode in which the clutch is slipped to reduce the load on the engine which allows the engine to rev to maximum torque before locking the clutch on.

Brief Description of the Drawings

A specific embodiment of the present invention will now be described by way of example only, and with reference to the accompanying drawings in which:

Figure 1 is a section through de-coupling clutch embodying the present invention; and

Figure 2 shows the de-coupling clutch of Figure 1 and an associated control system.

Figures 3a to 3d schematically illustrate the use of the de-coupling clutch of Figure 1 in various watercraft having differing transmission systems.

Detailed Description of a Preferred Embodiment

Referring to Figure 1, a marine de-coupling clutch 10 for a watercraft embodying the present invention is shown. The clutch is enclosed in a casing 11. An

input in the form of a rotating shaft having torque provides drive via a damper 12 to an input shaft 14.

The input shaft 14 is connected to an output shaft 16 via a clutch means 18.

The clutch means 18 includes friction plates 20 which are splined to the input shaft 14. A single clutch area is provided. Drive is provided to the output shaft 16 through the clutch steel plates 22 which are splined to clutch drum 24 which is in turn, splined to the output shaft 16. The clutch further includes a piston 26 which is arranged to provide force to compress the friction plates 20 and steel plates 22 together. There is only a drive path through the clutch when the friction plates 20 and steel plates 22 are forced together by the piston.

The force provided by the piston is controlled by controlling the pressure in the piston using direct acting high flow electro hydraulic solenoids 36 (refer to Figure 2). When pressure is not supplied, a return spring 30 pushes the piston off. Pressure is supplied to the solenoids through an axially mounted pump 28 linked to a regulator valve. The system includes a centrifugal dam 34 to prevent the clutch self-applying due to rotational speed.

With reference to Figure 2, the system includes an embedded control system which monitors driver input, and includes an input speed sensor 38, an output speed sensor 40 and a temperature sensor 42 whose signals are fed to an electronic control unit 44 which control the slip speed (the output speed minus the input speed). The control system controls the output speed through control of piston pressure via an electrical signal sent to the electro hydraulic solenoid 36. The electronic control unit may receive input signals indicative of the engine's throttle position 26 and gear position 48. The system may receive electronic requests for the various modes that the system operates in such as docking, trolling, hi-launch energy, via a CAN/BUS 50 for example from any suitable input such as buttons, levers, radio controls or the like. For a high launch energy mode, the engine speed is increased with the de-coupling clutch disengaged, and the clutch then engaged to provide a sudden impetus to the watercraft.

Thus, the present invention provides a stand alone controllable clutch which is entirely independent of the transmission of the watercraft. The system does not change the direction of rotation of the transmission shaft.

The system may be fitted to any type of marine propulsion system such as jet drives, outboards, etc in which it acts as a speed control device. The system does not change drive direction and is not rotation direction sensitive.

The clutch may also be used to achieve slip to protect the driveline of a marine craft, when the craft's propeller contacts obstacles such as branches, the sea bed, rocks

or the like. The clutch may be used to maintain continuous slip to achieve high energy launches, in which the engine is driven at high rpm with the clutch slipping and the clutch is then engaged to accelerate the craft rapidly.

Figures 3a to 3d schematically illustrate the use of the de-coupling clutch in a number of different watercraft having different drive systems. Figure 1 illustrates the use of the decoupling clutch 10 in a boat 302 driven by an outboard motor 304 in which the de-coupling clutch is installed in the drive shaft 306 between the motor 308 and propeller 310.

Figure 3b illustrates the use of the decoupling clutch 10 in a boat 320 with an inboard/outboard drive in which the decoupling clutch 10 is disposed between the inboard engine 322 and the outboard drive 324.

Figure 3c illustrates a yet further boat 340 which includes a shaft drive in which a de-coupling clutch is disposed in the output shaft between the engine/transmission 324 and propeller 344. Although an in-line shaft drive is shown, the de-coupling clutch may also be used with offset and step down shaft drives.

Figure 3d illustrates a boat 360 having a V-drive system in which the de-coupling clutch is installed in the drive shaft 361 between the engine 362 and propeller drive 364.

The above are only examples and the system may be used in watercraft having other types of drive system.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.